Application of Intelligent Agents to Seamless Business: Design of a Smart Business

Mohsen AKBARI and Mahdi JALILI-KHARAAJOO
Institute for Trade Studies and Research
240 Karghar Avenue, Tehran 14178, IRAN

Abstract. Examining potentials of agents in electronic environment in which companies can proceed their activities thoroughly, we propose two conceptual models describing know-how of using agents in strategic decisions. The first model presents a big picture of using intelligent agents in a competitive environment, where all the competitors are struggling virtually. The second one prototypes a typical competitor from the interior perspective with more details. This work is a beginning and a stand stone to open a breakthrough toward constructive a smart business media.

Keywords: Smart business, intelligent agents, virtual markets, e-business, e-commerce.

1. Introduction

In recent years, many researchers in intelligent agents domain have focused on the design of market architectures for electronic commerce (E-commerce) [1,2], and on protocols governing the interaction of self-interested agents [3] engaged in such transactions. While providing support for direct agent negotiation, the existing architectures for multiagent virtual markets usually lack explicit facilities for handling negotiation protocols [4,5], since they don't provide such protocols as an integrated part of the framework.

Complexity and uncertainty are the main specifications of the environment; most of the managers have many problems in adapting their companies to the environment, also it brings about heavy costs for the companies to be very flexible and adaptive. Designing strategies that can respond to the changes in the environment is a complicated and very time-consuming task. Strategic planning in a formal approach does not lead the corporate to be adaptive enough while a learning way the corporate can be dynamic to the changes in the environment.

Simulating a virtual market in which intelligent agents assist their users and act on their behalf can help managers to be flexible to the changes of the environment. Through a relation of collaboration-interaction with its user, the agent is able to learn from her, from the external world and even from other agents, and consequently acts independently from the user, adapts itself to different experiences and therefore change its behavior according to them.

In virtual markets pace of changes increase drastically, so the overwhelming responsibility of managers to design dynamic strategies increase accordingly. Managers have to create a strategic plan that embeds learning in their strategies to respond flexibly enough to the changes in the environment. Through agents that manipulate operational strategies, we can design a corporate that implements learning to its strategies. At first we try to design a marketing strategy by which the corporate executes its plans through marketing mix. Agents designed to each marketing mix are responsible for understanding and creating changes in the marketing strategy. Therefore, at first we have to design these micro-agents that deal with marketing mix.

2. Introduction to Virtual Markets

Software agent technology is starting to create a series of new possibilities for the area of electronic commerce [6]. Agents can be used to automate, and enhance many stages of the traditional consumer-buying behavior process. Through the minimization of transaction costs, elimination of geographic barriers and time issues, many new markets, not viable before, are now being created. Traditional markets are becoming

more efficient, and the role of the middleman has been changing drastically [7].

This paper proposes a software engineering approach to the design of agent mediated e-commerce systems, through the definition and implementation of an object oriented (OO) framework. This framework focuses mainly on e-commerce applications based on virtual marketplaces. A virtual marketplace is an Internet based system, in which software agents interact and negotiate, on behalf of their respective users, to buy, sell, or find specific goods and services. Meanwhile sellers and buyers can develop, promote, price, and distribute their products virtually through the agents. In this type of system, all users can be potential buyers, sellers or both, depending on their specific interests.

The main goal of V-Market is to facilitate the creation of this type of applications, as well as to make them more robust and flexible. It is expected that this approach will greatly enhance the process of experimentation, and research on the new possibilities brought about by software agents to the ecommerce application domain.

V-Market gives developers the ability to customize virtual marketplaces, and define transaction categories on demand, incorporating many possible products and services that can be traded online. Its users can create new transaction types and items based on individual needs, defining customized software agents adapted to the new products and offered services. Software agents in V-Market pro-actively broker and negotiate with interested buyers and sellers represented by their respective agents. They can be created with any set of desired behaviors, thereby enabling the consumer to have a virtual presence in the marketplace to further his or her interest, while freeing the consumer from constant monitoring of market progress.

"*The marketplace is the place of exchange between buyers and sellers. Once one rode a mule to get there; now one rides the Internet. An electronic marketplace can span two rooms in the same building or two continents*".

From V-Market's perspective, virtual marketplaces are Internet based systems that allow software agents to interact and negotiate, on behalf of their respective users, to buy, sell, or find specific goods. However, these systems must have some additional features:

Customer to customer: All users can be potential buyers, sellers or both, depending on their specific interests, which means it is a market for customers to customers, in which there are no predefined product offer or merchant entities.

Centralized: It is a semantically centralized system, which means that although the systems can be internally distributed (run on more than one machine), to the outside user, it is a unique centralized marketplace, in which all participants meet to broker and negotiate their belongings.

Kasbah [8] is a perfect example of a system based on a virtual marketplace. Its users go to the marketplace (represented through a web site) to find, buy or sell their items. This is done through the creation of agents that can be seen as "smart ads" that will not only broker corresponding ads, but also negotiate the item.

V-Market is an object-oriented framework for the virtual marketplace domain, which follows the above definitions. All systems instantiated by V-Market are semantically centralized, and there is no intrinsic distinction between buyers and sellers. One last restriction added is that all brokering and negotiation process happens asynchronously, which means that users create their agents with their respective control parameters and item description at a specific time and the brokering and negotiation process starts at that moment, but continues over time, completely independent of the users' presence, not requiring any type of real-time interaction.

The virtual value chains in the marketspace for competitive successes in information-based markets are so important. The creation of a marketspace in cyberspace will make it necessary for companies to reconsider the way they regard value-creating measures. In the future, a company will be able not only to achieve consumer values through physical value adding in the marketplace but also through virtual value adding in marketspace [9]. The value chain divides a company into strategically-relevant activities and identifies physically and technologically distinguishable value activities, for which the customer is prepared to pay. In this case, information also plays an important role in terms of competitive success because it is through information that existing processes can be better analyzed and controlled. However, this information has until now been seen simply as a supporting element rather than a source of value to the consumer in its own right. The interrelations between physical (marketplace) and virtual value chains (marketspace) as well as the creation of new markets can be seen in Fig. 1.

Fig. 1. The path from the physical to the virtual value chain

Owing to the significance of marketspace, a common value matrix will exist in the future, in which there will be an intensification of different value chains. This argument is also put forward by Rayport and Sviokla in [10,11] in which the existence of a freestanding value chain in marketspace was considered in terms of the formation of new outputs through information processes. The relevance of these arguments depends on the extent to which the product is linked to information technology. Generally it can be assumed that this link is stronger in the case of durable consumer goods than goods with a short life cycle. A first summary point and recommendation for action at this stage would be: The growth in information technology and networks will lead to a division of market systems into marketplace and marketspace which is important for competition. Virtual value creation activities enable performance improvements and supplements to be achieved in the marketplace and freestanding outputs to be offered in marketspace. The value creation activities in both market systems should ideally be combined in a common value matrix.

3. Agent based virtual market

An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors. A human agent has eyes, ears, and other organs for sensors, and hands, legs, mouth, and other body parts for effectors. A robotic agent substitutes cameras and infrared range finders for the sensors and various motors for the effectors. A software agent has encoded bit strings as its percepts and actions.

A software agent is neither a new concept nor a well-defined one. Although not clearly defined, agents have been used for quite some time in many different fields of computer science, and depending on the field of study, its definition may vary. For the purposes of this work, an agent is defined as a piece of software (not dependent on its implementation language) used to automate specific tasks. This piece of software also needs to be proactive, to be capable of personalization, and to have a certain level of autonomy. Other features, such as mobility and collaboration, might be desirable for some applications, but are not considered as prerequisites for this definition.

Personalization: The ability of the agent to be customized through information provided, explicitly or implicitly, by its user. Examples of such personalization are different parameters or domain restrictions for a search agent, or a maximum price and a negotiation strategy for a shopping agent.

Proactive: Agents should not simply act in response to external events. An agent should have a main goal, and should take the initiative, whenever necessary, to accomplish its goal.

Autonomous or semi-autonomous: An autonomous agent has the ability to complete its tasks without the intervention of its users, which means that agents should have a considerable degree of control over its own actions.

Although concepts such as intelligence, adaptability, mobility and cooperation are, many times, closely related to agents, we do not consider them prerequisites for defining an agent, but orthogonal concepts of the agent definition. These concepts are going to be seen as desirable features depending upon the task to be performed by the agent.

Intelligent/adaptive: An agent's intelligence is directly related to its developer's ability to define its behavior. Therefore, this property is quite subjective, and most of the researchers prefer to call them semi-intelligence. There are two schools of thought on the development of the so called "smart" or "semi-intelligent agents": One is in favor of the creation of a complex set of predefined rules that defines the agent's behavior (specialist systems like). The other favors a

simpler set of rules in which agents are capable of analyzing their actions and their surrounding environment as a way of "learning" how to be more efficient. This is sometimes identified as the ability to be adaptive.

Mobile: Agents can be classified as mobile or non-mobile (sometimes referred as anchored agents). Non-mobile agents reside either in a client or in a server machine, and do all their work on either one or the other. A mobile agent, on the other hand, has the ability to "navigate" through servers collecting information or performing other small actions in order to complete its task.

Cooperative/interactive: Agents can act on their own, or can cooperate and interact with others agents to complete their tasks. Buying agents can interact with selling agents to try to close a deal [7,8,12]. Alternatively, agents can exchange information about their respective users in order to complete their tasks in recommendation systems [13].

Given the exponential increase on information resources available on the Internet (World Wide Web), software agents have been given a lot of attention lately. Agents have the distinguishing ability to automate repetitive and time consuming tasks, including searching, buying and selling products over the Internet. Most of the tasks involved in the consumer buying behavior process [7,12,14] can be automated. Stages, such as identification of needs, product brokering, merchant brokering, and negotiation, can now be assisted or automated by many different agent-based systems. Merchants are currently struggling to explore new channels to negotiate their products, looking for opportunities to maximize their profits and, at the same time, to satisfy consumers. However, most of the electronic commerce stores available on the web today still take the form of static "catalogs" of products, in which customers select items manually, and purchase them online. So far, this model has fallen short on redefining the marketplace [12]. It is expected that software agents will turn existing markets into more efficient ones, and will change the role of the middleman, and make many small niche markets viable [15].

Artificial intelligence (AI) continues to play a significant role in many leading information systems. In the past, its use has been limited due to its complexity, monolithic designs and lack of knowledgeable system developers. AI contribution is now crucial in nondeterministic systems such as workflow, data mining, production scheduling, supply chain logistics, and most recently, ecommerce. Its new form is not the monolithic AI systems of the past, but distributed artificial intelligence, popularly known as intelligent agent technology. Intelligent agent technology is the next logical step in overcoming some shortcomings in e-commerce. Namely, successful computer systems underlying ecommerce require judgment and the knowledge of experts such as buyers, contract negotiators and marketing specialists [16].

Using agent based technology; one can support almost all stages of the Consumer Buying Behavior (CBB) model (Fig. 2), with the main parts being the stages 3 and 4, while also including parts of the stages 1, 2 and 5.

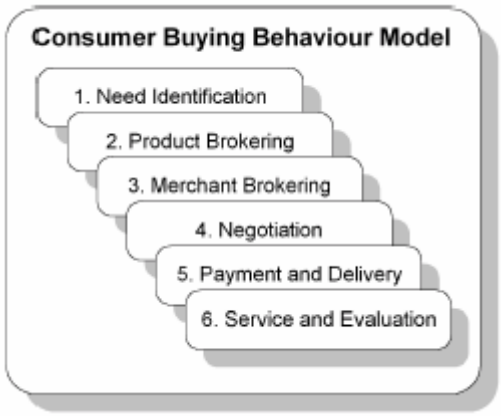

Fig. 2. Consumer Buying Behavior Model

The **need identification** stage is supported with notification and advertisement features, keeping the consumer up to date with new products and goods available on the market and in current or future auctions, corresponding with the consumers' interest profile.

Product brokering is achieved by matching user-set attribute priorities with available products. Related and alternative products can be offered by the sell agents, according to the users preferences.

The **merchant brokering** stage**,** as one of the main functions of the system, is using the central database in which all agents are registered. Each order request is matched with sell agents claiming to supply the desired product. The buyer can then pre-select the sellers he wants to negotiate with, using user-set filtering rules. The buy agent also selects auctions to bid on, if they offer the desired product.

In the **negotiation** stage the agents negotiate with each other, using pre-defined rule-based strategies selected by the individual user, while also incorporating learning strategies to refine their

approach. The agents can also use strategies when bidding in auction, depending on the auction type.
Finally, the **payment and delivery** stage is supported by using online payment systems. Actual online delivery of the good is possible if the product is in electronic form. Physical goods are shipped the traditional way by the sellers themselves.
One of the possible reference models of a microeconomic market for *mediated* learning resources brokerage and exchange is presented in Fig. 3 [17]. The proposed market model is based on interactions between three types of actors: *consumers*, *producers* and *mediators*.

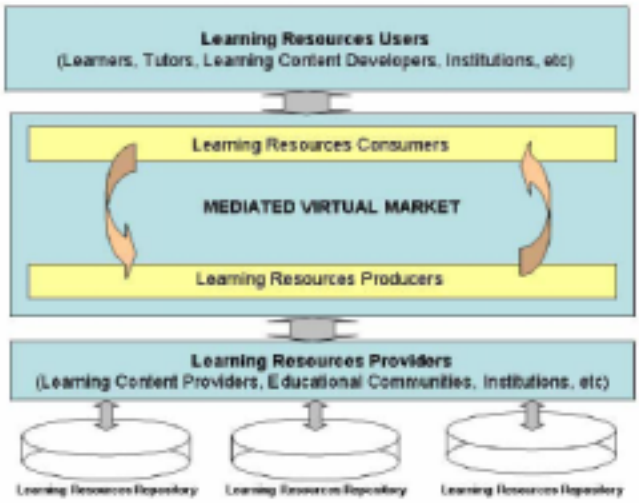

Fig. 3. Learning Resources Virtual Mediated Market Model

Producers are learning resources providers who publish learning object advertisements (metadata descriptions) to the mediator role (for example, they make offers to all consumers in the proposed market model and/or wait until a request is published by a consumer).
Consumers are learning resources users (learners, tutors or other content providers) who are searching for learning objects (for example, they make specific requests to the mediator role and collect offers from interested producers, or search throughout the advertisements until they locate a learning object that suits their needs).
Mediators are the main brokerage implementation entities, as they can play different roles according to the market mechanism design: they can be simple facilitators of the interactions of the producers and consumers (directory facilitators); or they can play an active role in the market mechanism (be auctioneers, or proactive matchmakers).

4. Big picture of an intelligent competitor

It is very important that an organization consider its environment before beginning the marketing process. In fact, environmental analysis should be continuous and feed all aspects of planning. The organization's marketing environment includes as follow:

- The internal environment e.g. staff (or internal customers), office technology, wages and finance, etc.
- The immediate or microenvironment e.g. external customers, agents and distributors, suppliers, our competitors, etc.
- The remote or macro-environment e.g. Political (and legal) forces, Economic forces, Socio-cultural forces, and Technological forces. These are known as **PEST** factors

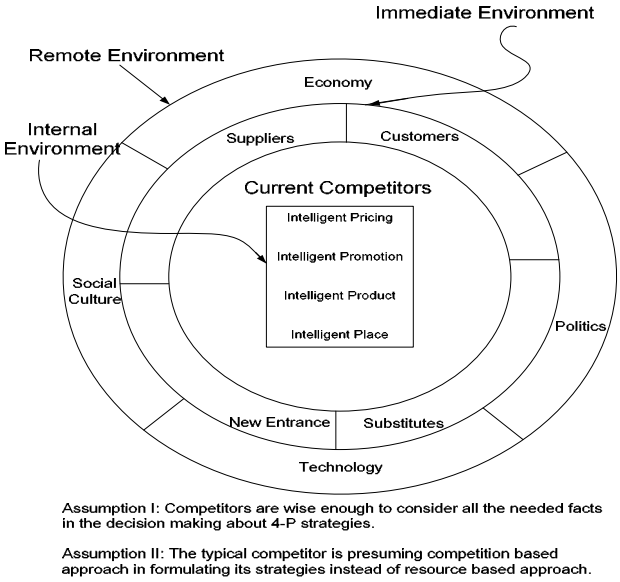

Fig. 4. External picture of proposed agent based smart business presume

4.1. The internal environment

All factors that are internal to the organization are known as the 'internal environment'. They are generally audited by applying the 'Five Ms' which are Men, Money, Machinery, Materials and Markets. The internal environment is as important for managing change as the external. Nevertheless, because of pursuing competence-based approach in strategy formulation (our

assumption II) our typical competitor does not consider these facts in its strategic decision-making.

4.2. The Immediate or Micro-environment

This environment influences the organization directly. It includes suppliers that deal directly or indirectly, consumers and customers, and other local stakeholders) mostly called five forces). Five forces looks at five key areas namely the threat of entry, the power of buyers, the power of suppliers, the threat of substitutes, and competitive rivalry.

4.3. The Remote or Macro-environment

This includes all factors that can influence and organization, but that are out of their direct control. A company does not generally influence any laws. It is continuously changing, and the company needs to be flexible to adapt. There may be aggressive competition and rivalry in a market. The wider environment is also ever changing, and the marketer needs to compensate for changes in culture, politics, economics, and technology.

Political Factors: The political arena has a huge influence upon the regulation of businesses, and the spending power of consumers and other businesses.

Economic Factors: Marketers need to consider the state of a trading economy in the short and long-terms. This is especially true when planning for international marketing.

Socio-cultural Factors: The social and cultural influences on business vary from country to country. It is very important that such factors are considered.

Technological Factors: Technology is vital for competitive advantage, and is a major driver of globalization.

Our typical competitor with an eye on its wise competitors can understand what is going in the market (Assumption I). Here on behalf of the competitor, the intelligent agent is observing market changes that already have embedded environment data and changes.

Management information System (MIS): According to different definitions of MIS, "systems that provide timely, reliable, and useful information to managers in business, industry, and government" and "an organized assembly of resources and procedures required to collect, process, and distribute data for use in decision making", two main subsystems can be derived from MIS that are Data Warehouse and Data Filtering [18-20].

Data Warehouse (DW): Abbreviated DW, a collection of data designed to support management decision making. Data warehouses contain a wide variety of data that present a coherent picture of business conditions at a single point in time

Data Filtering: A pattern through which data is passed. Only data that matches the pattern is allowed to pass through the filter.

Expert System: programming computers to make decisions in real-life situations. A computer program that contains expert knowledge about a particular problem, often in the form of a set of if-then rules, that is able to solve problems at a level equivalent or greater than human experts

Intelligent System (IS): It is a system that learns during its existence. (In other words, it learns, for each situation, which response permits it to reach its objectives.) It continually acts, mentally and externally, and by acting reaches, its objectives more often than pure chance would indicate (normally much more often).

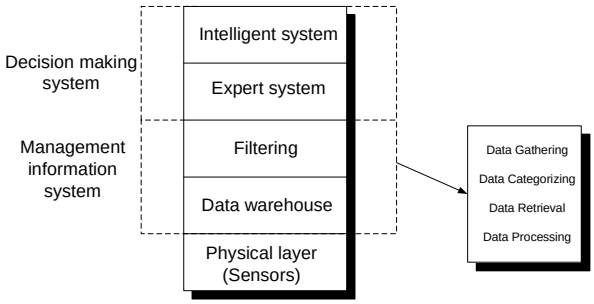

Fig. 5. Internal picture of proposed agent based smart business

5. Conclusions

Intelligent agents with their capabilities are very constructive and facilitator media in the world of the Internet. Intelligent agents can help managers to be flexible to the changes of the environment in virtual markets. The agent, through a relation of collaboration-interaction with its user, is able to learn from her, from the external world and even from other agents, and consequently acts independently from the user, adapts itself to different experiences and therefore change its behavior according to them. In this paper, we tried to model the behavior of intelligent agents in virtual markets; how they interact with outsiders and how it works internally, as well. To this end,

we proposed two conceptual models of intelligent agent-based smart business.

Reference:

[1] P. Maes, A. Chavez. Kasbah: An Agent Marketplace for Buying and Selling Goods. *In Proc. Conference on Practical Applications of Intelligent Agents and Multi-Agent Technology*. April 1996.

[2] M. Tsvetovatyy, M. Gini, B. Mobasher, Z. Wieckowski. MAGMA: An Agent-Based Virtual Market for Electronic Commerce. *Applied Artificial Intelligence, special issue on Intelligent Agents*, No 6, September 1997.

[3] T.W. Sandholm. Negotiation among self-interested computationally limited agents. PhD Thesis, University of Massachusetts, 1996.

[4] J. S. Rosenschein, G. Zlotkin. *Rules of Encounter*. MIT Press, 1994.

[5] R.G. Smith, The Contract Net Protocol: *high-level communication and control in a distributed problem solver. In Readings in distributed artificial intelligence* (A.H. Bond & L. Gasser), pages: 357-366, Morgan Kauffmann publishers 1988.

[6] Bradshaw, J. (1997), *Software Agents*, the MIT Press.

[7] Guttman, R., P. Maes, A. Chavez, and D. Dreilinger (1997), Results from a Multi-Agent Electronic Marketplace Experiment, In *Proceedings of Modeling Autonomous Agents in a Multi-Agent World (MAAMAW'97)*, Ronneby, Sweden.

[8] Chavez, A. and P. Maes (1996), Kasbah: An Agent Marketplace for Buying and Selling Goods. In *Proceedings of the First International Conference on the Practical Application of Intelligent Agents and Multi-Agent Technology* (PAAM'96), London, UK.

[9] Porter, M.E. (1985), *Competitive Advantage*, the Free Press, New York, NY.

[10] Rayport, J.F. and Sviokla, J. J. (1994), Managing in the marketspace, *Harvard Business Review*, Vol. 72 No. 6, pp. 141-50.

[11] Rayport, J.F. and Sviokla, J. J. (1995), Exploiting the virtual value chain, *Harvard Business Review*, Vol. 73 No. 12, pp. 75-87.

[12] Guttman, R. and P. Maes (1998), Agent-mediated Integrative Negotiation for Retail Electronic Commerce, In *Proceedings of the Workshop on Agent Mediated Electronic Trading (AMET'98)*.

[13] Firefly Inc. (1996), Firefly Network Inc., http://www.firefly.com.

[14] Moukas, A., R. Guttman, and P. Maes (1998), Agent-mediated Electronic Commerce: An MIT Media Laboratory Perspective, *In Proceedings of the First International Conference on Electronic Commerce (ICEC'98)*, Seoul, Korea.

[15] Chislenko, A. (1998), *Hypereconomy*, Dow Jones' Markets Magazine.

[16] Fingar, P. (1998), A CEO's Guide to eCommerce Using Object-Oriented Intelligent Agent Technology, June, 1998, http://home1.gte.net/pfingar/eba.htm.

[17] Manouselis, N. and Sampson, D (2003), Learning Resources Brokerage Systems: an Agent-based Virtual Market Model, *Proceedings of the The 3rd IEEE International Conference on Advanced Learning Technologies (ICALT'03)*.

[18] Kenneth C. Laudon, Jane P. Laudon (2003), *Management Information Systems*, Eighth Edition, Prentice Hall.

[19] Kenneth C. Laudon, Jane P. Laudon (2002*), Essentials of Management Information Systems* (5th Edition), Prentice Hall.

[20] Gerald V. Post, David L. Anderson (2002), *Management Information Systems: Solving Business Problems with Information Technology*, McGraw-Hill/Irwin; 3rd edition